

WHAT IS CLAIMED IS:

1. In an enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a closure member movable between closed and fully open positions in said access opening for selectively allowing and restricting said access to said interior chamber, the improvement comprising:

at least one primary counterweight, a primary connecting member interconnecting said primary counterweight and said closure member for movement therewith, and a primary roller member mounted for rotation about an axis of rotation, said primary roller member being engaged by said primary connecting member intermediate said primary counterweight and said closure member for rotation by said primary connecting member in response to movement of said closure member;

at least one secondary counterweight, a secondary roller member arranged to rotate with said first roller member, and a secondary connecting member interconnecting said secondary roller member and said secondary counterweight, said secondary member movably winding and unwinding on said secondary roller member in response to movement of said closure member;

said closure member being movable to at least one predetermined intermediate position between said closed and fully open positions, with said secondary connecting member winding and unwinding from said secondary roller member in a first moment-producing direction on said secondary roller member when said closure member is moved between said closed position and said intermediate position, and with said secondary connecting member winding and unwinding on said secondary roller member in a second moment-producing direction on said secondary roller member when said closure member is moved between said intermediate position and said fully open position, said second moment-producing direction being opposite to said first moment producing direction.

2. The improvement according to claim 1, wherein said primary and secondary counterweights maintain said closure member in a substantially stationary at-rest condition when said closure member is located at said predetermined intermediate position between its fully open and fully closed positions.

3. The improvement according to claim 1, wherein said closure member is a sash member movable generally vertically between said fully closed and open positions.

4. The improvement according to claim 1, wherein said primary connecting member is a toothed belt, and wherein the outer periphery of said primary roller member has teeth thereon enmeshingly engaging said toothed belt.

5. The improvement according to claim 1, wherein said secondary connecting member is a cable having one end fixedly interconnected to said secondary roller member.

6. The improvement according to claim 1, wherein said primary connecting member is a cable having a traction-surface thereon for positively engaging said primary roller member.

7. The improvement according to claim 6, wherein said secondary connecting member is a cable having one end fixedly interconnected to said secondary roller member.

8. The improvement according to claim 1, wherein said primary connecting member is a chain, and wherein said primary roller member is a sprocket enmeshingly engaging said chain.

9. The improvement according to claim 1, wherein there are two primary counterweights and wherein there are two primary connecting members for connecting said two primary counterweights to said closure member, and wherein two primary rollers are provided for engagement with said two primary connecting members, respectively, with said two primary rollers being connected to rotate together about an axis of rotation.

10. The improvement according to claim 9, wherein said two primary rollers and said secondary roller are connected together by a shaft for rotation about the axis of rotation of said shaft.

11. The improvement according to claim 10, wherein said secondary counterweight is attached to said shaft at a location intermediate said primary counterweights.

12. The improvement according to claim 1, wherein there are two primary connecting members and two corresponding primary rollers, and wherein each of said two primary connecting members is connected to said primary counterweight and to said closure member and is in engagement with one of said primary rollers.

13. The improvement according to claim 12, wherein said two primary rollers and said secondary roller are connected together by a shaft for rotation about the axis of rotation of said shaft.

14. The improvement according to claim 1, wherein said primary roller and said secondary roller are joined integrally as a double-grooved pulley that is mounted for rotation about an axis of rotation.

15. The improvement according to claim 14, wherein said double-grooved pulley is mounted for rotation on a shaft extending across said interior chamber.

16. The improvement according to claim 1, wherein the outer peripheries of primary and secondary roller members have substantially the same diameter.

17. The improvement according to claim 1, wherein the outer peripheries of primary and secondary roller members have different diameters.

18. The improvement according to claim 1, wherein said primary and secondary roller members are pulleys.

19. In an enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a closure member movable between closed and fully open positions in said access opening for selectively allowing and restricting said access to said interior chamber, the improvement comprising:

at least one primary counterweight, a primary connecting member interconnecting said primary counterweight and said closure member for movement therewith, and a primary roller member mounted for rotation about an axis of rotation, said

primary roller member being engaged by said primary elongated link member intermediate said primary counterweight and said closure member for rotation by said primary connecting member in response to movement of said closure member;

a pair of secondary counterweights, a respective pair of secondary roller members rotatably fixed relative to said primary roller member for rotation therewith, and a pair of respective secondary connecting members each having an end portion fixedly interconnected with a respective one of said secondary roller members and an opposite end portion fixedly interconnected with a respective one of said secondary counterweights, said secondary connecting members movably winding and unwinding on said secondary roller members in response to movement of said closure member;

said closure member being movable to first and second predetermined intermediate positions between said fully closed and fully open positions, with each of said secondary connecting members winding and unwinding in a first moment-producing direction on one of said respective secondary roller members, respectively, when said closure member is moved between said closed position and said first intermediate position, and with one of said secondary connecting members winding and unwinding in said first moment-producing direction on one of said respective secondary roller members and the other of said secondary connecting members winding and unwinding in a second opposite moment-producing direction on the other of said respective secondary roller members when said closure member is moved between said first intermediate position and said second intermediate position, and with both of said secondary connecting members winding and unwinding in said second moment-producing direction on said respective secondary roller members when said closure member is moved between said second intermediate position and said fully open position,

20. The improvement according to claim 19, wherein said secondary counterweights produce respective opening moments assisting said opening movement of said closure member when said respective secondary connecting members wrap and unwrap on said respective secondary roller members in said first moment-produce direction, and produces second respective closing moments assisting said closing movement of said closure member when said respective secondary connecting members wrap and unwrap on said respective secondary roller members in said second opposite moment-producing direction .

21. The improvement according to claim 19, wherein said primary and secondary counterweights maintain said closure member in a substantial stationary at-rest condition when said closure member is at a predetermined intermediate position between said fully closed position and said fully open position.

22. The improvement according to claim 19, wherein said closure member is a sash member movable generally vertically between said fully closed and open positions.

23. The improvement according to claim 19, wherein said primary connecting member is a toothed belt, and wherein said primary roller member has teeth thereon enmeshingly engaging said toothed belt.

24. The improvement according to claim 19, wherein said secondary connecting members are cables, each having one end fixedly interconnected to said one of said respective secondary roller members.

25. The improvement according to claim 19, wherein said primary connecting member is a cable having a traction-surface thereon for positively engaging said of said primary roller member.

26. The improvement according to claim 24, wherein said second connecting members are cables, each having one end fixedly interconnected to said one of said respective secondary roller members.

27. The improvement according to claim 19, wherein said primary connecting member is a chain, and, wherein said primary roller member is a sprocket enmeshingly engaging said chain.

28. The improvement according to claim 19, wherein said primary roller member and said secondary roller members have substantially the same diameter.

29. The improvement according to claim 19, wherein said primary roller member has a different diameter than the diameters of said secondary roller members.

30. The improvement according to claim 28, wherein said secondary roller members have diameters that are different from the diameter of said primary roller member.

31. The improvement according to claim 19, wherein said primary and secondary roller members are pulleys.

32. In a fume hood enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a sash member movable generally vertically between closed and fully open positions in said access opening for selectively allowing and restricting said access to said interior chamber, the improvement comprising:

at least one primary counterweight, a primary connecting member interconnecting said primary counterweight and said sash for movement therewith, a rotatable axle, and a first pulley rotatably fixed relative to said rotatable axle for rotation therewith, said first pulley being movably engaged by said primary connecting member between said primary counterweight and said sash for rotation in response to movement of said sash;

a secondary counterweight, a second pulley rotatably fixed relative to said rotatable axle for rotation therewith, and a secondary connecting member having an end portion fixedly interconnected with said second pulley and an opposite end portion fixedly interconnected with said secondary counterweight, said secondary connecting member movably winding and unwinding on said second pulley in response to movement of said sash;

said sash further being movable to at least one predetermined intermediate position between said closed and fully open positions, said secondary connecting member wrapping and unwrapping in a first moment-producing direction on said second pulley when said sash is moved between said closed position and said intermediate position, said secondary connecting member movably winding and unwinding in a second opposite moment-producing direction on said second pulley when said sash is moved between said intermediate position and said fully open position, and

said secondary counterweight producing an opening moment assisting said opening movement of said sash when said secondary connecting member wraps and unwraps on said second pulley in said first moment-producing direction and producing a closing moment assisting said closing movement of said sash when said secondary connecting

member wraps and unwraps on said second pulley in said second opposite moment-producing direction .

33. The improvement according to claim 32, wherein said primary and secondary counterweights maintain said sash in a substantial stationary at-rest condition when said sash is at a predetermined intermediate position between said fully closed and fully open positions.

34. In an enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a closure member movable between closed and fully open positions in said access opening for selectively allowing and restricting said access to said interior chamber, the improvement comprising:

at least one counterweight;

at least two connecting members, each interconnecting said counterweight and said closure member; and

at least two guide members disposed between said counterweight and said closure member with said two connecting members extending over said two guide members, respectively, so that said counterweight and said closure member move together in opposite vertical directions, said two guide members being positioned so that the portions of said two connecting members extending between said support members and said closure member extend at an angle to vertical that varies as said closure member moves between said closed and fully open position to thereby vary the effective vertical counterweight forces exerted on said closure member by said counterweight.

35. The improvement according to claim 34, wherein said two guide members are rollers spaced from one another, and wherein said closure member moves in a vertical path of movement that is between said rollers.

36. The improvement according to claim 34, wherein said effective vertical counterweight force is equal to the weight of said closure member when said closure member is moved to a predetermined intermediate position between said fully open and fully closed position of said closure member.

37. In an enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a closure member movable between closed and fully open positions in said access opening for selectively allowing and restricting said access to said interior chamber, the improvement comprising:

a counterweight;

a connecting member connecting said counterweight to said closure member;

at least one guide member disposed between said counterweight and said closure member with said connecting member extending over said guide member so that said counterweight and said closure member can move together in opposite vertical directions; and

a track member disposed in the path of said vertical movement of said counterweight and extending at an angle to the vertical path of movement of said counterweight whereby said counterweight will engage said track member during a predetermined portion of its downward movement and will be moved at an angle away from said vertical path of movement to thereby vary the effective vertical counterweight force exerted on said closure member by said counterweight.

38. The improvement according to claim 37, wherein a rotatable engagement member is mounted on said counterweight and positioned to rotatably engage said track member.

39. The improvement according to claim 37, wherein the portion of said connecting member extending between said guide member and said counterweight extends in a vertical direction during movement of said counterweight when it is not in engagement with said track member and will extend at an angle to vertical when said counterweight is in engagement with said track member.

40. The improvement according to claim 39, wherein said angle of said connecting member portion increases as said counterweight moves downwardly along said track member.

41. The improvement according to claim 37, wherein there are two said guide members, wherein there are two said connecting members, and wherein said guide members



are located vertically above said counterweight so that the portions of said connecting members extending between said guide members and said counterweight will extend in a vertical direction during movement of said counterweight when it is not in engagement with said track member and will extend at an angle to vertical when said counterweight is in engagement with said track member, said angle increasing as said counterweight moves downwardly along said track member.

42. In an enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a closure member movable between closed and fully open positions in said access opening for selectively allowing and restricting said access to said interior chamber, the improvement comprising:

- a counterweight;
- a first connecting member connecting said counterweight to said closure member;

- at least one guide member disposed between said counterweight and said closure member with said first connecting member extending over said guide member so that said counterweight and said closure member can move together in opposite vertical directions; and

- a second connecting member extending between said counterweight and a fixed element in said enclosure, said second connecting member having a fixed length and said fixed element being located to cause said second connecting member to move said counterweight at an angle away from said vertical direction of movement to thereby vary the effective vertical counterweight force exerted on said closure member by said counterweight.

43. The improvement defined in claim 42, wherein said effective vertical counterweight force is varied to result in such force being less than the weight of said closure member when said closure member moves between said fully open position and a predetermined intermediate position between said fully closed and fully open positions, and to result in the such force being substantially equal to said weight of said closure member when it is at said predetermined intermediate position.

44. A method of controlling the movement of a closure member disposed in an access opening of an enclosure to cause said closure member to automatically return to a

predetermined position between the fully opened and fully closed positions of said closure member when is it moved away from said predetermined intermediate position, said method comprising the steps of:

(a) providing a primary counterweight that moves with said closure member and acts oppositely to the weight of said closure member during movement thereof between said open and closed positions; and

(b) providing a secondary weight which moves with said closure member and which acts oppositely to the weight of said closure member during movement thereof between said fully closed position and said predetermined intermediate position thereof, and which acts oppositely to the weight of said primary counterweight during movement thereof between said fully closed position and said predetermined intermediate position thereof, whereby said secondary weight acts to assist in moving said closure member toward said predetermined intermediate position thereof whenever it is moved away from said predetermined intermediate position toward its fully opened position.

45. A method as defined in claim 44, wherein said method includes the steps of connecting said closure member to said primary counterweight with a primary connecting member, connecting said secondary weight to said secondary counterweight with a secondary connecting member, and utilizing said primary and secondary connecting members to rotate a rotatable member.

46. A method as defined in claim 45, wherein said step of utilizing said connecting members to rotate a rotatable member includes causing said secondary connecting member to be wound about said rotatable member in one direction of rotation when the weight of said secondary counterweight is acting oppositely to the weight of said closure member, and causing said secondary connecting member to be wound about said rotatable member in the opposite direction of rotation when the weight of said secondary counterweight is acting oppositely to the weight of said primary counterweight.

47. A method of controlling the movement of a closure member disposed in an access opening of an enclosure when is it moved between its fully opened position and its fully closed position, said method comprising the steps of:

(a) providing a connecting member having a first predetermined width along a first segment of its extending length and having a second predetermined width along a second segment of its extending length which is less than said first predetermined width;

(b) providing a rotatable pulley that is formed with a groove having a gradually increasing spacing between the sides of the groove along its radially outward extent;

(c) connecting said connecting member to said closure member and to a counterweight with said first and second segments of said connecting members being located intermediate said closure member and said counterweight; and

(d) positioning said connecting member in said groove of said pulley so that during a first portion of said movement of said closure member between its fully opened and fully closed positions said first segment of said connecting member is within the groove of said pulley, and so that during a second portion of said movement of said closure member between its fully opened and fully closed positions said second segment of said connecting member is within the groove of said pulley, whereby the effective weight of said counterweight opposing the weight of said closure member can be varied.

48. A method of controlling the movement of a closure member as defined in claim 47, wherein said first segment of said connecting member is positioned in said groove of said pulley when said closure member is located between its fully closed position and a predetermined intermediate position between said fully open and fully closed positions, and wherein said second segment of said connecting member is located in the groove of said pulley when said closure member is located between said fully open position and said predetermined intermediate position.

49. A method of controlling the movement of a closure member as defined in claim 48, wherein said connecting member is formed with a transition portion connecting said first and said second segments thereof, and wherein said transition portion of said connecting member is positioned in said groove of said pulley when said closure member is located at said predetermined intermediate position.

50. A method of controlling the movement of a closure member disposed in an access opening of an enclosure when is it moved between its fully opened position and its fully closed position, said method comprising the steps of:

(a) connecting said closure member to at least one counterweight using two connecting members, respectively, with said two connecting members connected to said closure member at two separate points having a first spacing therebetween;

(b) positioning two guide members above said closure member with a generally horizontal second spacing therebetween that is greater than said first spacing; and

(c) positioning said two connecting members to pass over said two guide members, respectively, so that said guide members are located intermediate said closure members and said counterweight and so that the portion of said connecting members extending between said closure member and said two guide members extend at an angle that is offset from vertical and that changes as said closure member moves between said fully opened and closed positions thereof to vary the effective weight of said counterweight acting on said closure member.

51. A method of controlling the movement of a closure member disposed in an access opening of an enclosure as defined in claim 50, wherein said closure member is caused to automatically return to a predetermined intermediate position between the fully opened and fully closed positions of said closure member by said counterweight when is it moved away from said predetermined intermediate position toward its fully opened position.

52. A method of controlling the movement of a closure member disposed in an access opening of an enclosure when is it moved between its fully opened position and its fully closed position, said method comprising the steps of:

(a) connecting said closure member to a counterweight using a first connecting member that is connected to said counterweight at a first point along its widthwise extent and using a second connecting member that is connected to said counterweight at a second point spaced generally widthwise from said first point;

(b) positioning two guide members intermediate said closure member and said counterweight for receiving said first and second connecting members, respectively, and guiding them to normally move said counterweight in a vertical direction of movement opposite to the direction of movement of said closure member;

(c) disposing a ramp member in the path of said vertical movement of said counterweight that extends at an angle to vertical; and

(d) causing said counterweight to engage said ramp member during a portion of said vertical movement thereof and then move in an angled direction relative to its normal vertical movement to thereby vary the effective weight of the counterweight acting oppositely to the weight of said closure member.

53. A method of controlling the movement of a closure member disposed in an access opening of an enclosure as defined in claim 52, wherein said closure member will automatically return to a predetermined intermediate position between the fully opened and fully closed positions of said closure member by said counterweight when is it moved away from said predetermined intermediate position toward its fully opened position, and wherein said counterweight engages said ramp member when said closure member moves away from its predetermined intermediate position toward its fully opened position.

54. A method of controlling the movement of a closure member disposed in an access opening of an enclosure when is it moved between its fully opened position and its fully closed position, said method comprising the steps of:

(a) connecting said closure member to a counterweight using a first connecting member;

(b) connecting one end of a second connecting member to said counterweight;

(c) positioning a first guide members vertically above said counterweight and intermediate said closure member and said counterweight for receiving said first connecting members and guiding said first connecting member to normally move said counterweight in a vertical path of movement opposite to the direction of movement of said closure member; and

(d) securing the other end of said second connecting member at a fixed location outside of said vertical path of movement of said counterweight positioned and positioned to cause said counterweight to move in a direction of movement that is at an angle to said normal vertical path of movement of said counterweight to vary the effective weight of said counterweight acting on said closure member.

55. A method of controlling the movement of a closure member disposed in an access opening of an enclosure as defined in claim 54, wherein said closure member is caused

to automatically return to a predetermined intermediate position between the fully opened and fully closed positions of said closure member by said counterweight when is it moved away from said predetermined intermediate position toward its fully opened position.

56. In an enclosure having an interior chamber, an access opening in said enclosure providing access to said interior chamber, a closure member moveable between fully closed and fully open positions in said access opening for allowing and selectively restricting said access to said interior chamber, the improvement comprising:

(a) at least one counterweight;

(b) a pulley located between said counterweight and said closure member, said pulley being formed with two sides that extend radially outwardly along gradually diverging extents to form a groove therebetween that gradually increases from the inner edge of the groove to the outermost edge of the pulley; and

(c) a connecting member interconnecting said closure member and said counterweight and disposed in said groove of said pulley, said connecting member having a first segment having a first predetermined width joined to a second segment having a second predetermined width that is less than the first predetermined width, whereby the effective weight of said counterweight as applied to the weight of said closure member is varied depending on which of first or second segments are disposed in said groove of said pulley.

57. The improvement according to claim 56, wherein said first segment of said connecting member is joined to said second segment of said connecting member by an intermediate transition segment, and wherein said intermediate transition segment is disposed within the groove of said pulley when said closure member is located at a predetermined intermediate position between its fully opened and fully closed positions.